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ON THE SHATTERING OF HIGH-STRENGTH HARD GLASS

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Translation of "O razrushenii vysokoprochnogo zakalennogo stekla."
Doklady Akademii Nauk SSSR 142, No. 1, 75-76 (1962)

Hard glass has considerable internal stresses, which are compensated in the entire space and in the case of shattering, lead to the fragmentation of the structure into small cells (Reference 1). Of ~~interest~~ are the kinetics of the breakage of hard glass and above all the sequence of its fragmentation, i. e. whether the small cells form at once or whether the glass divides into larger blocks, subsequently undergoing additional fragmentation. In the opinion of V. L. Indenbom (Reference 2), the occurring dimensions of cells can not originate at subsequent cleavage and are explained by the branching of fissures in the shattering process. In the present report, this problem is investigated by the high-speed movie film process.

For an object of study, we used sheet stalinite 6 mm thick, supported on two cutters running the length of the sheet. A blow was inflicted by means of a metal rod with the explosion of a detonator, held in a protecting ring. The filming was done with a type SFR-1 photorecorder at speed of 120,000 frames/sec. The light source was a group of pulse lamps. The detonator and the light flare were set off together by a control pulse from the photorecorder.

Individual photo frames of the shattering process are presented in Figure 1. The front of the shattering, formed by many cracks, as would be expected was spherical with its center at the point of impact. Cases of the branching of the cracks are clearly visible. As a result of propagation, the originating cracks can run radially or "tangentially", leading to a cellular fragmentation.

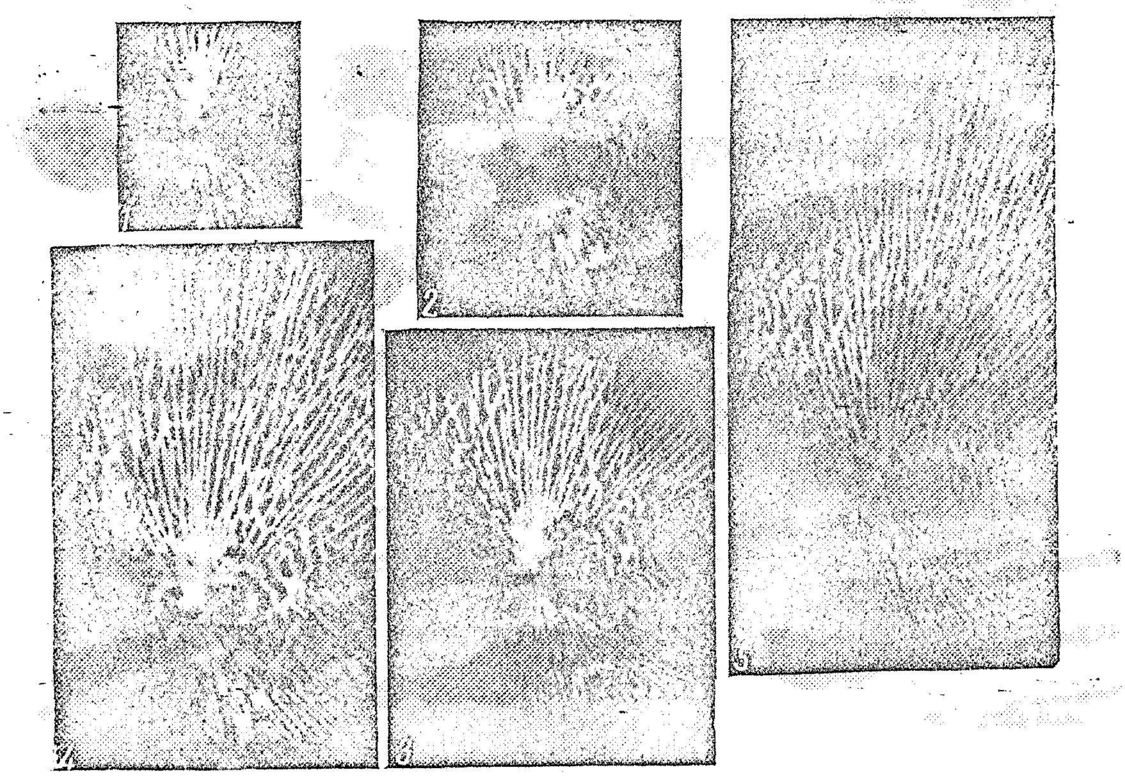

Figure 1. Motion picture frames of cracks in stalinite. The time is counted from the first frame (in secs.): $2 - 8.3 \cdot 10^{-6}$; $3 - 41.5 \cdot 10^{-6}$; $4 - 91.3 \cdot 10^{-6}$; $5 - 141.1 \cdot 10^{-6}$

The distance between the nearest radial cracks in the process of their growth naturally varies. In the initial stages, they equal the dimension of the cells after shattering. In this connection, the discharge of the resilient field is sufficiently complete and it is unnecessary to have an additional branching of the cracks. Then, when the cracks diverge, the release of the resilient energy leads to their propagation, favoring the development of bands of glass, close in size to those originating in the initial shattering stage.

Hence, one dimension of a future cell is developed directly in the process of the growth of the radial cracks. The second dimension of the cell is formed at branching of the lateral cracks, i. e. those which are "tangential" to the main ones (radial). It is worth noting that under the photographic method used, the horizontal tangential cracks are manifested relatively poorly. This is compensated by their good visibility on the periphery.

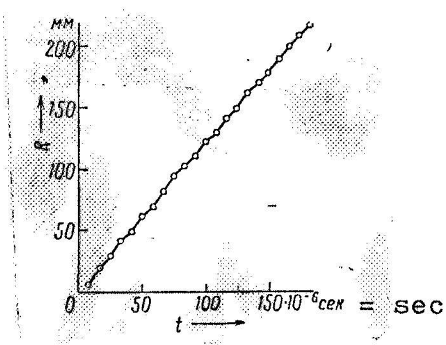

Figure 2. Temporal increase in radius of destruction front.

As a whole, the study conducted permits us to consider that most of the cells are formed in final appearance at once in the process of the growth and propagation of the cracks. At the same time, since the distances between the tangential cracks in a number of cases prove greater than the final dimensions of the cells, several of them can form during the later stages of disruption, by way of the fragmentation of a narrow strip of glass into a few splinters.

The radius of the destruction front as a function of time is depicted in Figure 2. The rate of cracks' propagation in stalinite reaches 1700 m/sec, which is close to similar velocities observed in glass previously (References 3-6).

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